HOMEMADE MORTAR CONSTRUCTION MANUAL

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Homemade Mortar Construction Manual
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Warning

The projects described use flammable fluids that could be dangerous when used. *Therefore, these plans are intended for information purposes only.*

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Introduction

Like a lot of people, we had heard several tales of other people's exploits with homemade mortars. We were intrigued by the thought of launching a tennis ball several hundred feet into the air. We had no idea how to build such a device, but tried anyway. Our first attempts failed miserably. We were never able to pin down exactly how others built this device.

That is, until one day a friend of a friend taught us the basics of mortar construction. This was the break we needed. That evening, working from only a small amount of information, we built the first of our mortars. It consisted of one combustion chamber and one launch section. Our initial ammo was a tennis ball, as it fit quite nicely in the launch tube. We were rather skeptical about the mortar working in light of our past failures, but our first test shot traveled over one hundred feet at a launch angle of 30 to 35 degrees. Despite the fact that the tennis ball almost slammed into the neighbor's house, we were hooked.

Our first mortar was a simple device made of two aluminum cola cans taped together with duct tape. One had the top and bottom cut off; the second just had a hole cut in the top. The top was left on the second can

so that the ball would have a place to rest above the combustion chamber. The hole allowed the hot combustion gases to escape into the barrel and force the ball outward. At the bottom of the combustion chamber we punched a small hole that allowed us to load and light a few drops of lighter fluid. This simple design was our entry into the world of mortaring.

It wasn't long before we started breaking the theory down and making bigger and better mortars. Once we had figured out the basics, we were able to break some kind of record with each new design, We also tried a lot of things that did not work so well.

One of our early failures was an egg-launching mortar. We discovered the hard way that when trying to launch eggs, it is important to *not* fire into a strong wind! You will end up, as we did, with egg all over your face, not to mention your hair, shirt, and pants.

Homemade mortars produce hot, rapidly expanding gases with projectiles coming out the ends, so they should never be pointed at any person, animal, or building, since it could cause severe damage to whatever the ball hits. Even when the mortar is unloaded but fueled, the ignition will produce a formidable flame coming out the end.

The biggest problem we've had over the years has been finding a range large enough and remote enough to fire our mortars. This is mainly due to the loud blast that is produced during ignition. We learned this the hard way, too. Once I was trying to flame-clean a new mortar in my backyard late at night. I put several drops of lighter fluid into the combustion chamber, waited a few seconds, and then lit it. Usually, there is a *pop* and a flame shoots out. This time, nothing happened at all.

Confused, I put in more fuel and tried to light it again. Still, nothing happened. Now thoroughly frustrated, I set the mortar aside for about ten minutes. Then, just out of curiosity, I tried to light it again. Besides a blinding four-foot flame shooting out the end, the resulting bang was deafening! My neighbor's windows rattled for a

disturbingly long time. I dropped everything, ran into my house, turned out all the lights, and hoped everyone thought it was thunder!

Included in this book are four designs which we have built and tested. Our favorite mortar ammo is a tennis ball because of its snug fit in the barrel, but any suitably sized object will work as long as there is a tight seal. Even a tennis ball cut in half so other material can be fitted inside (like gravel, dirt, eggs, or golf balls) will work. Throughout this manual we will be using a tennis ball as our launch object. Happy mortaring!

Parts List

The basic parts requirements for the mortar are quite simple. Below is a list of the parts and tools needed for both the basic and intermediate models.

Parts
4–6 empty 12-oz. soft drink cans
1 roll duct tape
tennis ball
plunger (yard stick, broom handle, etc.)
lighter fluid
empty nasal spray bottle
lighter

Tools
X-acto knife or other sharp, thin blade
metal shears
small, cylindrical object (spice bottle, small metal bar, salt shaker, etc.)
drill and drill bits

As you can see, the requirements to get started are rather modest. The construction of the mortar is also quite simple. At most, it should take less than two hours of construction

time with all the materials and tools at hand.

The parts list for the two advanced models is the same as the basic and intermediate models except for the following additions:

Parts
1-3 twenty-four-oz. beer cans
2-4 empty spray paint cans of the proper diameter

Tools
epoxy
can opener
sandpaper
soldering iron
solder
solvent (acetone)
metal file
flux

The construction of the advanced models is somewhat different from the other two models in that the advanced models are made from steel and aluminum rather than just aluminum. This will be covered further in the design chapters.

Design #1: Basic Model

This model is the smallest of the three designs, but it is still quite effective. We have gotten distances of over 200 feet using this construction. Its overall length should be about 16 inches, though this is not critical (it can be longer). The basic model consists of one combustion chamber and three sections of launch tubing. (See Figure 1.)

1. Empty, wash, and dry four soft drink cans. Set aside one can for the combustion chamber.
2. Cut off the tops of each of the three remaining cans. Draw a line all the way around the top of one can just below the point where it starts to bevel off. This is where the top will be cut off. Cut off the top with an X-acto blade or any other sharp, thin-bladed instrument. Stick the blade into the can on the line and cut all the way around until the top comes off. (See Figure 2.)
3. Once the top has been cut off, the edge of the can will be slightly deformed. Roll a small cylindrical object (such as a spice bottle, salt shaker, or thick metal rod) along the inside lip of the can to smooth out the deformity and rough edge. (See Figure 3.)

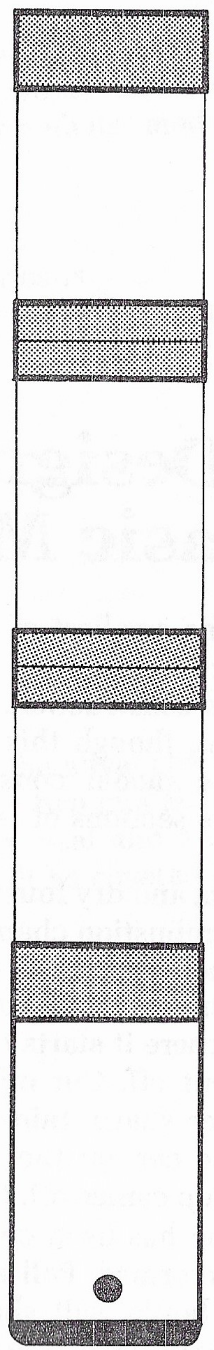

Figure 1 Tennis Ball Mortar

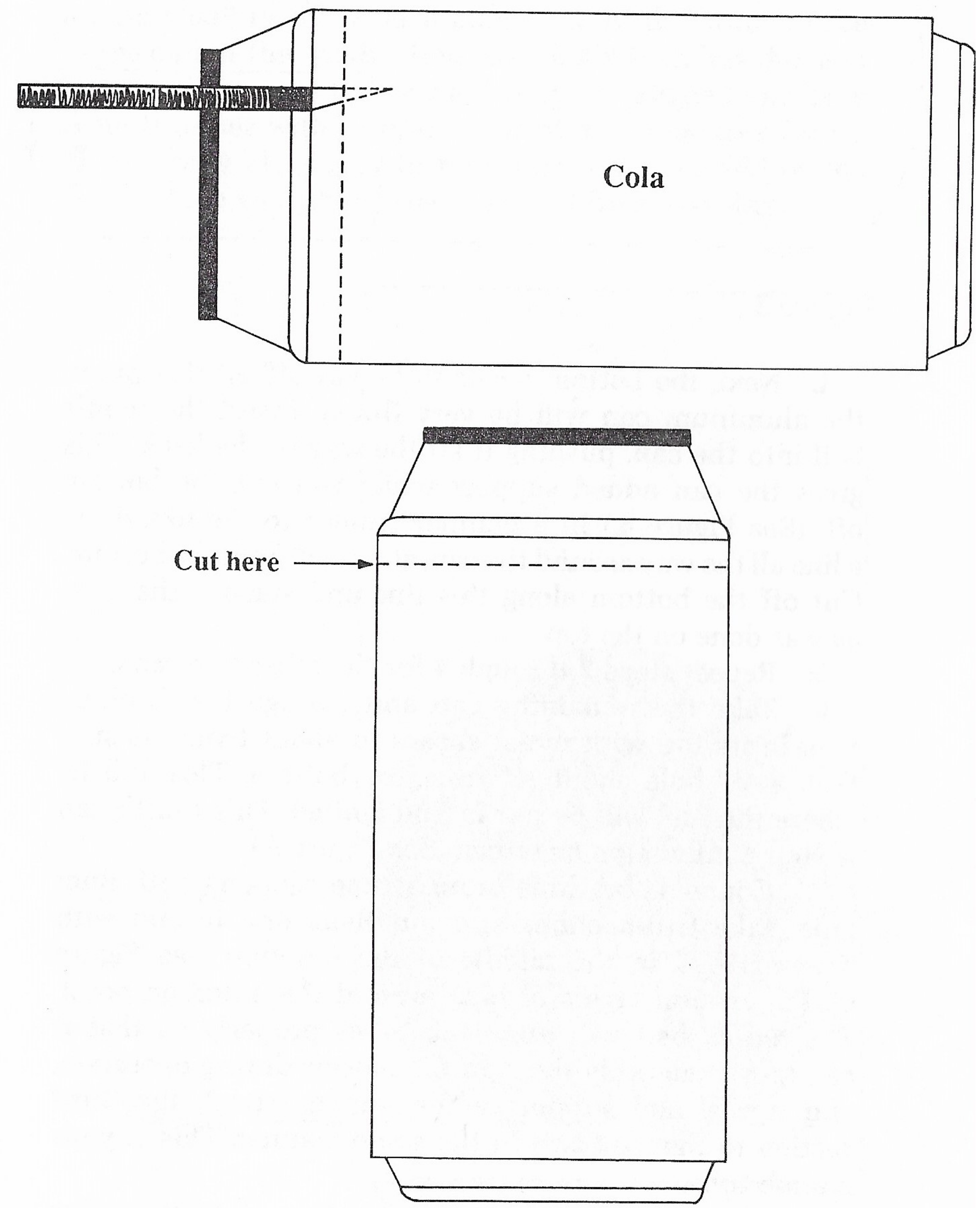

Figure 2

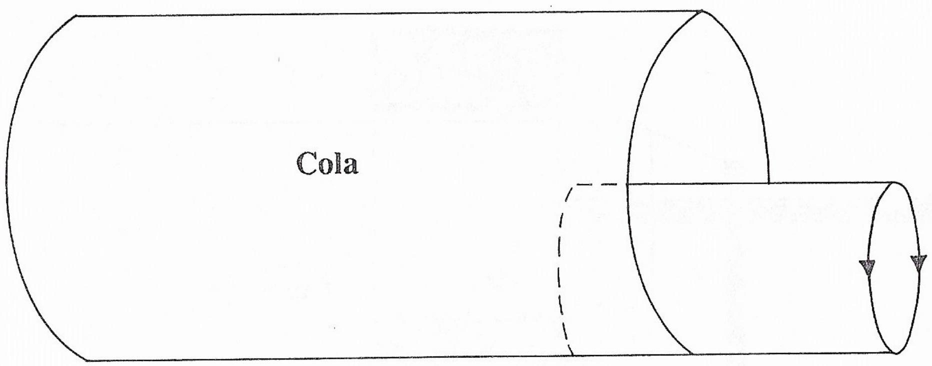

Figure 3

4. Next, the bottom needs to be cut off. At this point, the aluminum can will be very flimsy. Insert the tennis ball into the can, pushing it all the way to the back. This gives the can added support while you cut the bottom off. (See Figure 4.) In a manner similar to the top, draw a line all the way around the can, about ¼″ from the bottom. Cut off the bottom along this line and smooth the edge as was done on the top.

5. Repeat steps 2 through 4 for the other two cans.

6. Take the remaining can and enlarge the drinking hole in its top with metal shears to about twice its size. Drill a ⅛″ hole about ½″ from the bottom. This will be where the fuel will be put in and ignited. This fourth can is your combustion chamber. (See Figure 5.)

7. Connect the three launch tube sections with duct tape. Take two sections and put them end to end with a tennis ball in the middle of the junction (see Figure 6). Put several layers of tape around this junction point. The tennis ball will align the tubes properly so that it can move smoothly through the mortar during operation, and it will add support while taping. Attach the third section to the first two in the same manner. This is your launch tube.

8. The last step in the construction of your mortar involves attaching the launch tube to the combustion chamber. This is done in the same manner as the construction of the launch tube, except you do not need a tennis ball inside. Attach either end of the launch tube to the end of the combustion chamber which has the hole on top. Make sure the two are properly aligned and tape them together with several layers of duct tape (see Figure 7). You may also want to reinforce the open end of the launch tube with duct tape to keep it from warping.

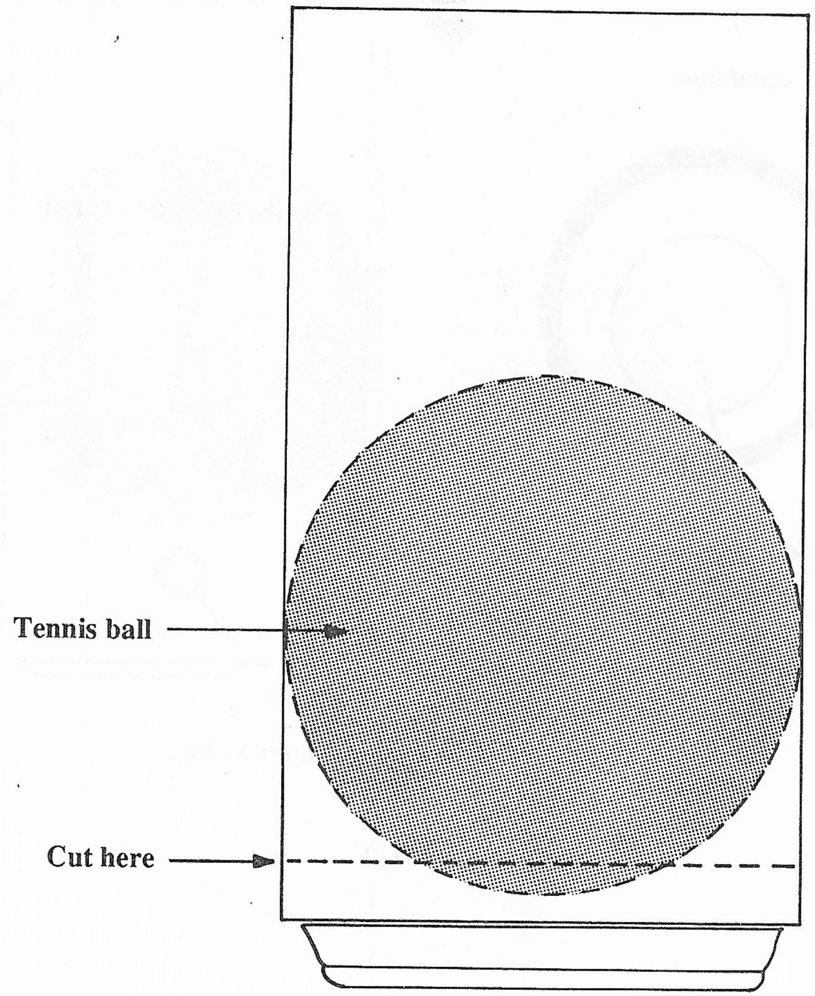

Figure 4

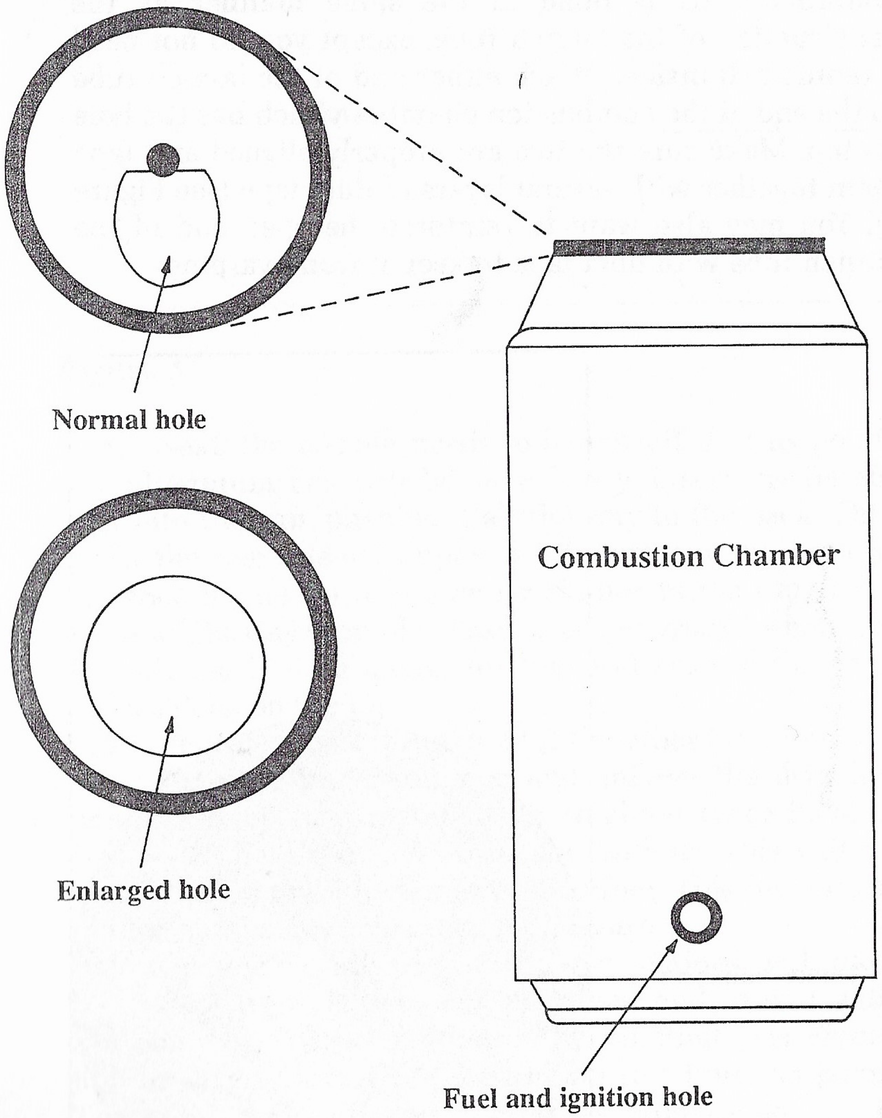

Figure 5

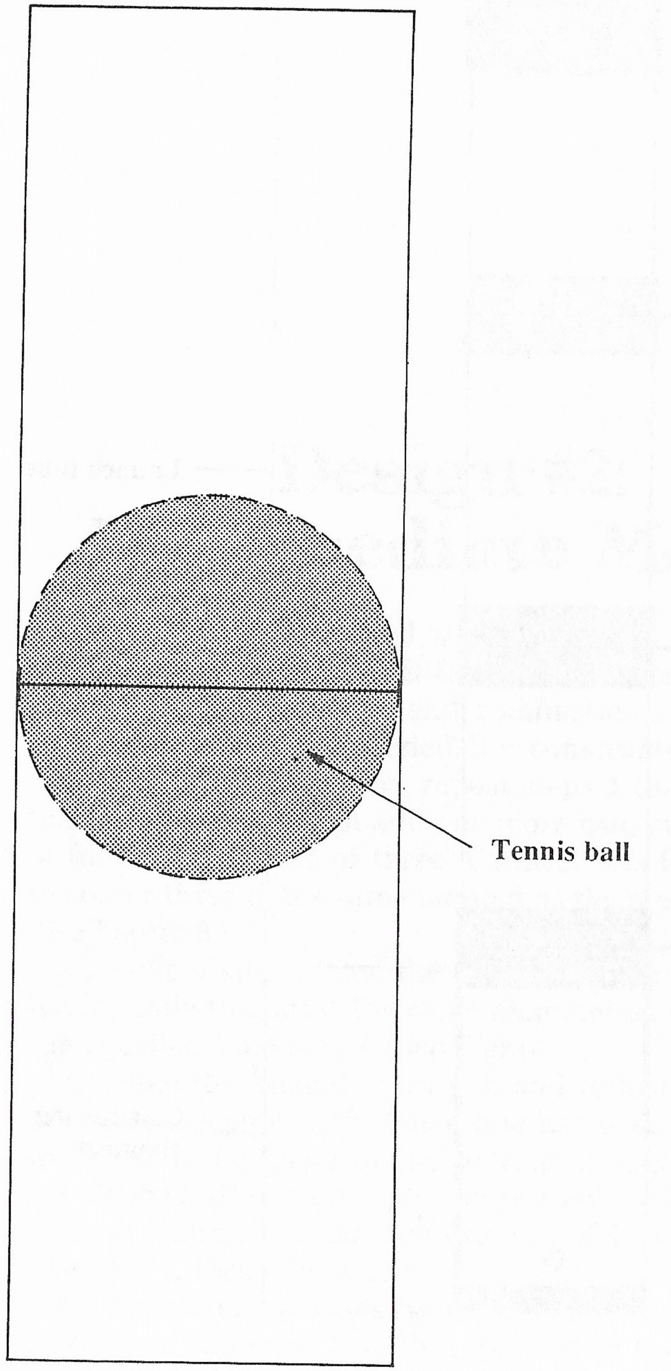

Figure 6

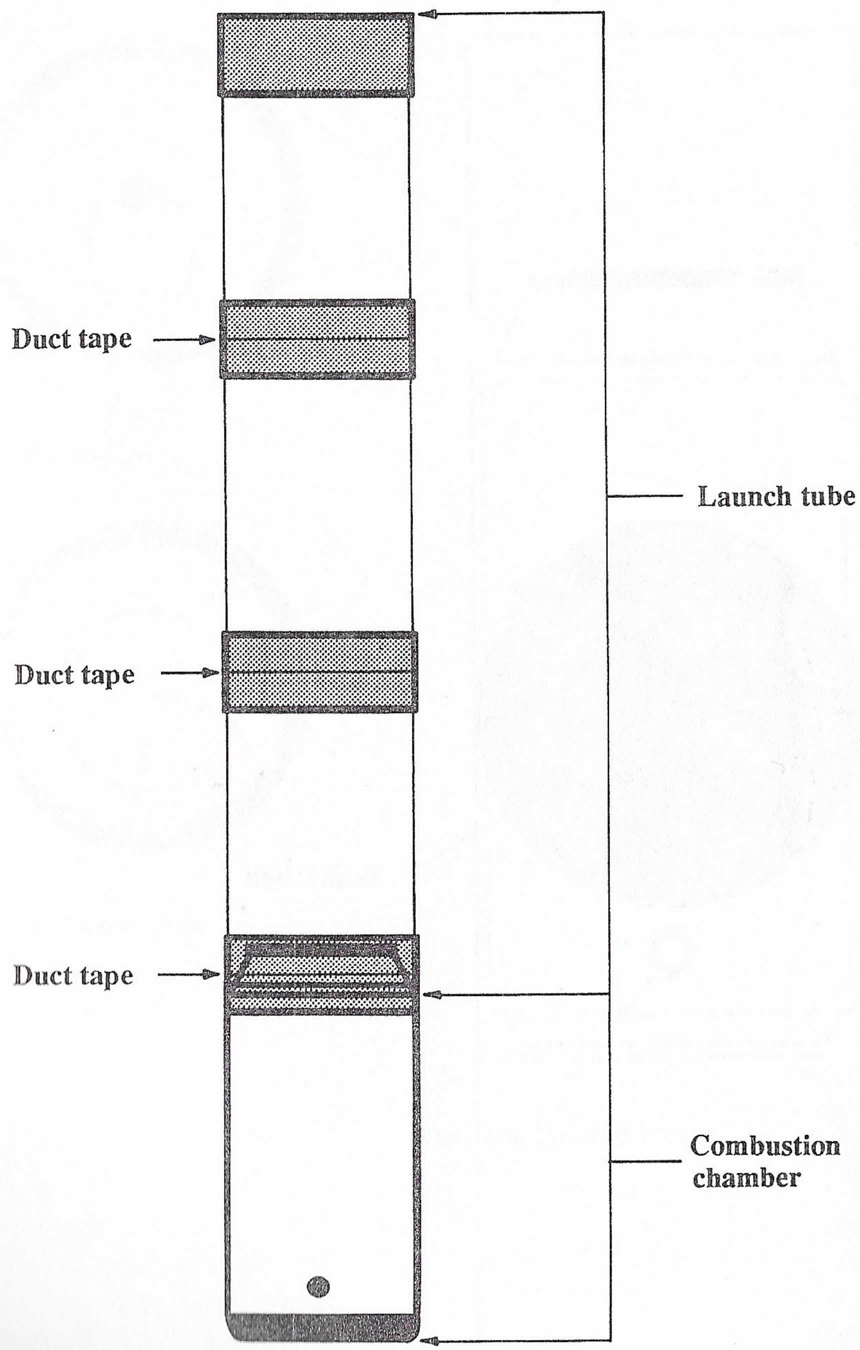

Figure 7

Design #2: Intermediate Model

The intermediate model is an extension of the basic model. The only physical differences between the two are an extended launch tube and combustion chamber. Two extra cola cans will be needed. It is constructed as follows:

1. For the launch tube, repeat steps 1 through 5 from the basic model, except add one more can, making a total of four cans instead of three. Connect this fourth can to the other three in the same manner as the previous model. (See Figure 8.)
2. Follow step 6 from the basic design, except enlarge the top hole to almost the same diameter as the can. This can is called Chamber 2. (See Figure 9.)
3. Take the second extra can and follow step 6 from the basic design exactly. Once this has been done, a hole will need to be made in the bottom of this can. Do *not* cut off the bottom, but put as large a hole in it as possible without taking off the bottom lip. This can is called Chamber 1. (See Figure 10.)
4. For the extended combustion chamber, set Chamber 1 on top of Chamber 2 so that the bottom lip in Chamber 1 sits nicely on top of Chamber 2. Align the fuel/ignition

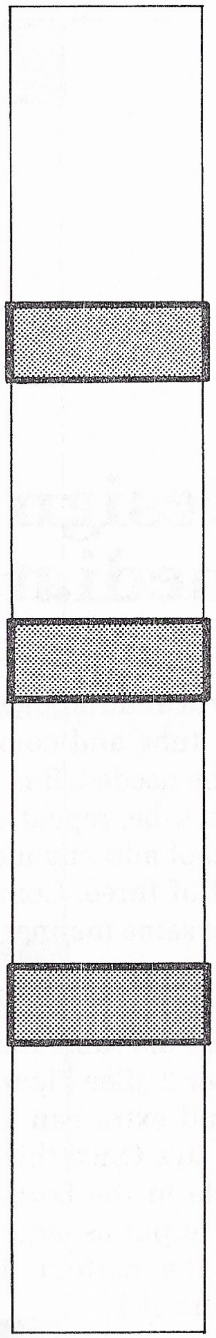

Figure 8

holes. Hold the cans tightly together and wrap several layers of duct tape around this joint. (See Figure 11.)

5. Attach the combined combustion chamber to the launch tube as in step 8 of the basic design.

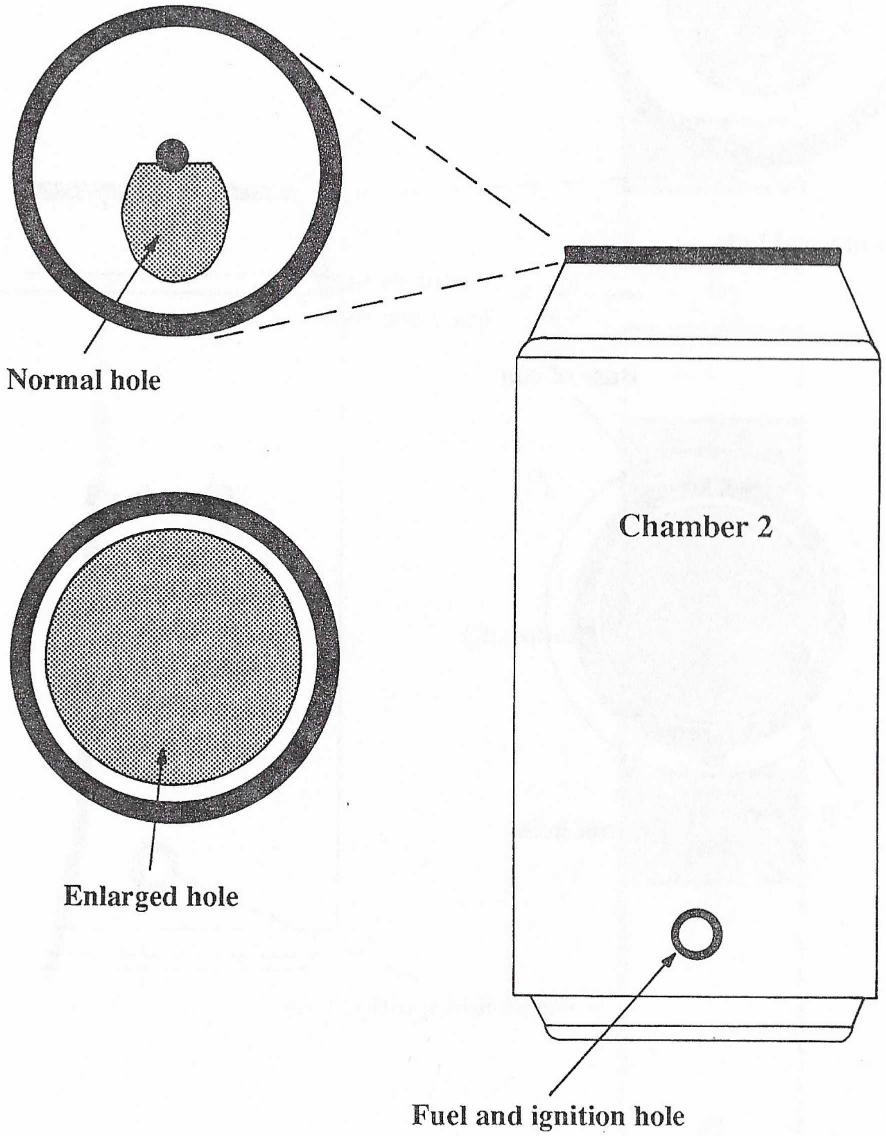

Figure 9

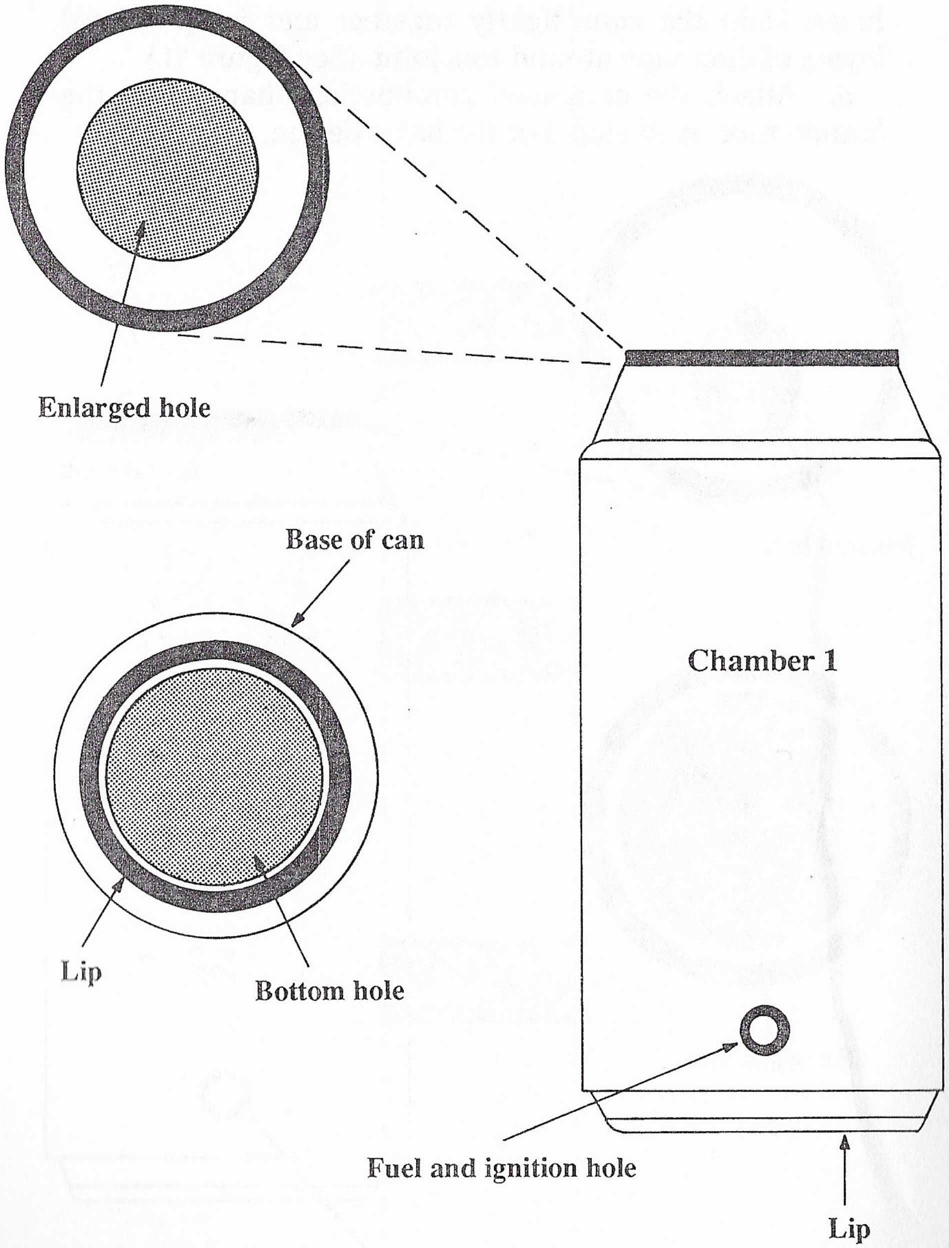

Figure 10

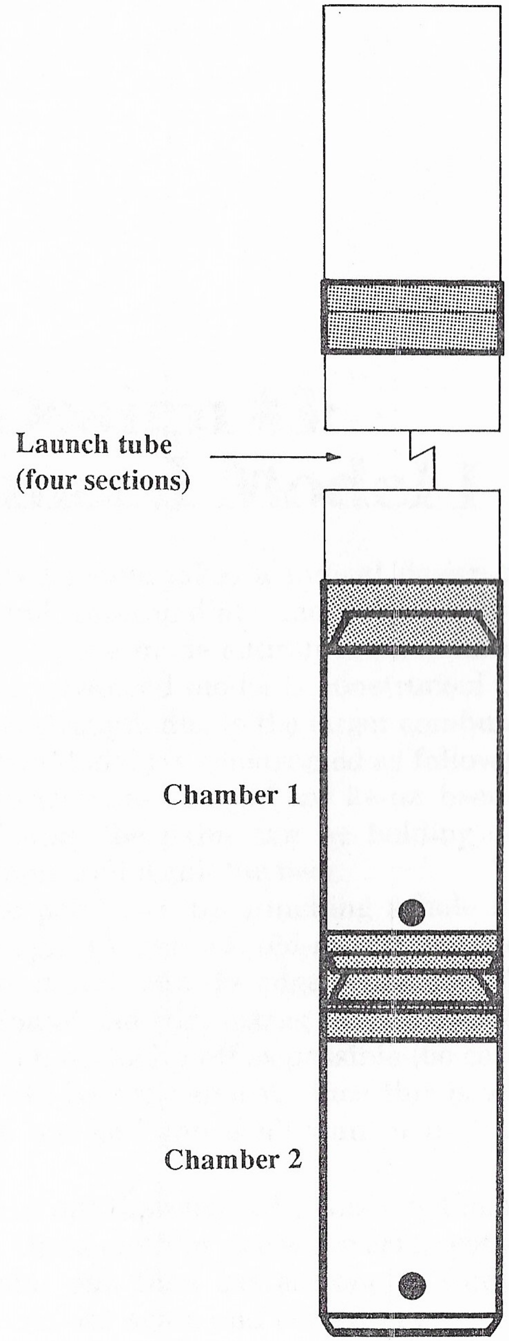

Figure 11

Design #3: Advanced Model I

The first advanced model takes a radical design turn from the basic and intermediate models. While the previous two models were made entirely from aluminum soft drink cans, the advanced model is constructed from steel cans for added strength due to the larger combustion chambers. Advanced Model I is constructed as follows:

1. Empty one spray paint can and one 24-oz. beer can. (See Figure 12.) Empty the paint can by holding down the nozzle until empty and drink the beer.
2. Open up the paint can by punching a hole in its bottom large enough to get an old-style can opener ("church key") into it and onto the edge of the can. Work the can opener around the rim, taking off the lip. Make sure you get as much of the lip off as possible (be careful, as the steel edge will be *very* sharp), since this is where the ball will come out and you don't want it to "catch" on anything.
3. Clean the cans out thoroughly by washing them out with lots of water. Use a cloth or paper towels to get most of the residual paint out, then use acetone to complete the job. Wash this can out again and wipe it dry.
4. Remove the upper portion on the top of the can

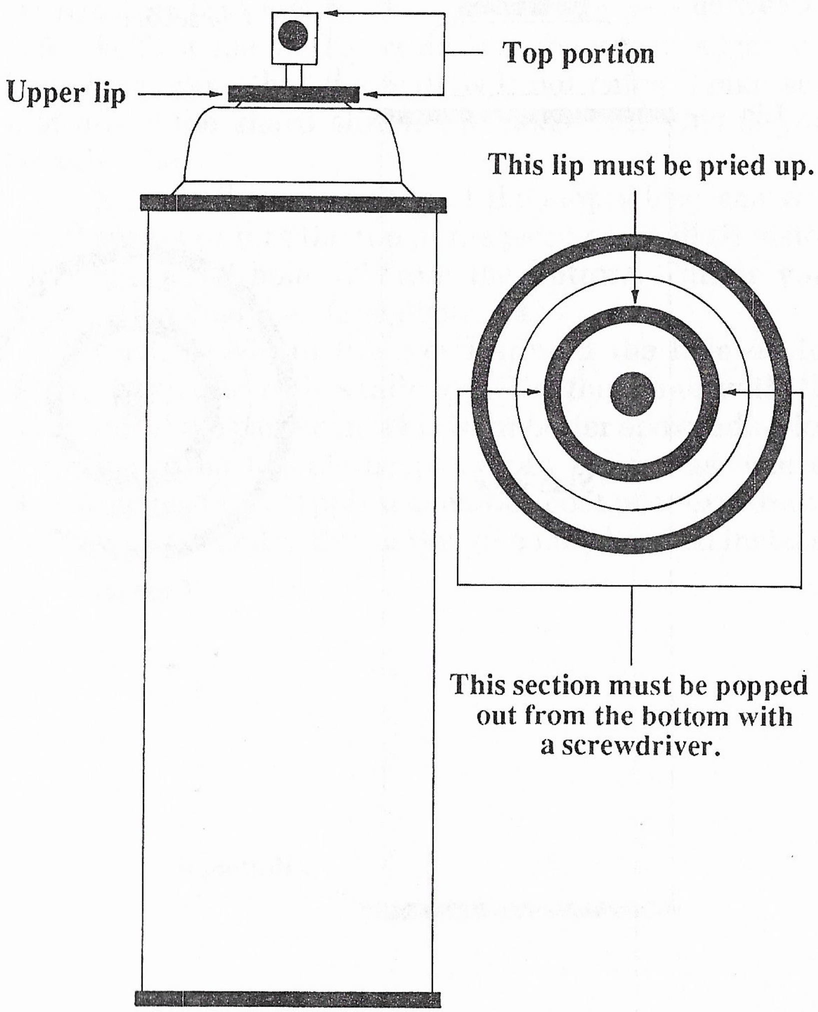

Figure 13

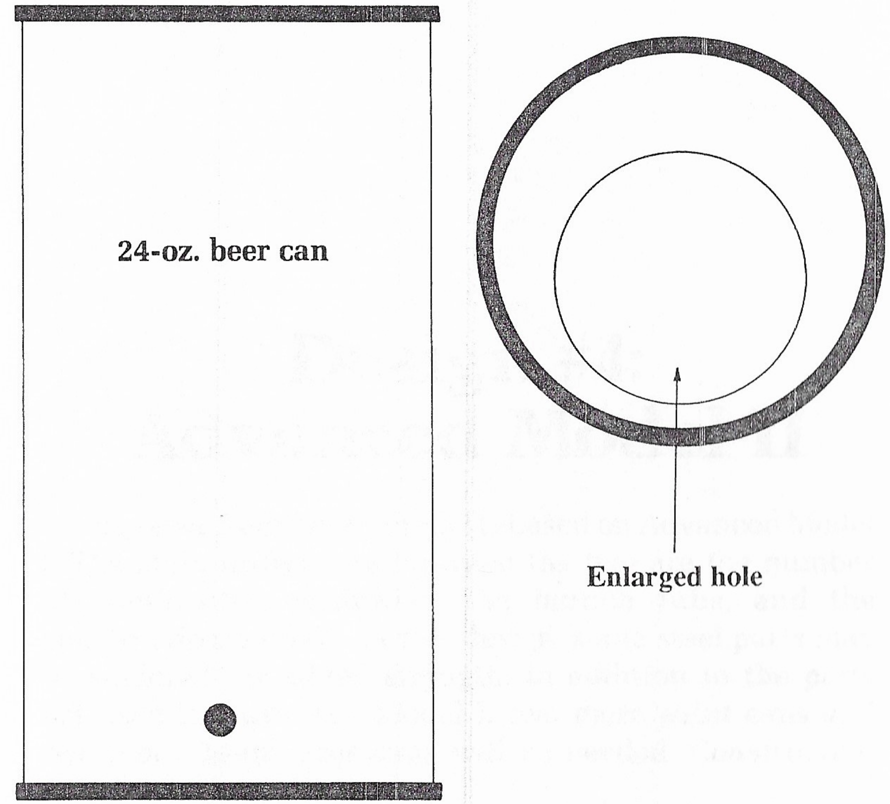

Figure 14

Design #4: Advanced Model II

The second advanced model is based on Advanced Model I. The main differences between the two are the number of combustion chambers, the launch tube, and the construction method. In this design, some steel parts may be soldered for added strength. In addition to the parts list used in Advanced Model I, two more paint cans and two more 24-oz. beer cans will be needed. Construction is as follows:

1. Follow the first three steps for Advanced Model I for all three paint cans.
2. For two of the paint cans described in step 1 above, remove the whole top part and remove the lip in the same manner as with Advanced Model I. (See Figure 15.)
3. Follow step 4 from Advanced Model I for the third paint can. (See Figure 13.)
4. Connect all three of the paint cans. The best way to do this is to solder them together at the joints and then epoxy over these joints to ensure an airtight seal. Align the joints with a tennis ball as with the basic and intermediate models. (See Figure 6.)
5. To construct the combustion chamber, alter one of

the beer cans in the same manner as step 6 of Advanced Model I, except remove the bottom of this can with metal shears. This is called Can A. (See Figure 16.)

6. The next section of the combustion chamber will be a second beer can with both the entire top and bottom removed. This is called Can B. (See Figure 16.)

7. Remove the entire top of the bottom can, called Can C. Unlike the launch tube, the aluminum combustion chamber sections cannot be soldered together without special equipment. Epoxy them together as securely as possible: A on top, B in the middle, and C on the bottom. Drill ignition/fuel holes near the bottom of all three cans. After epoxying the combustion chamber sections together, wrap the joints with duct tape for added strength. (See Figure 17.)

8. Attach the launch tube and combustion chamber to each other in same manner as in step 8 for Advanced Model I.

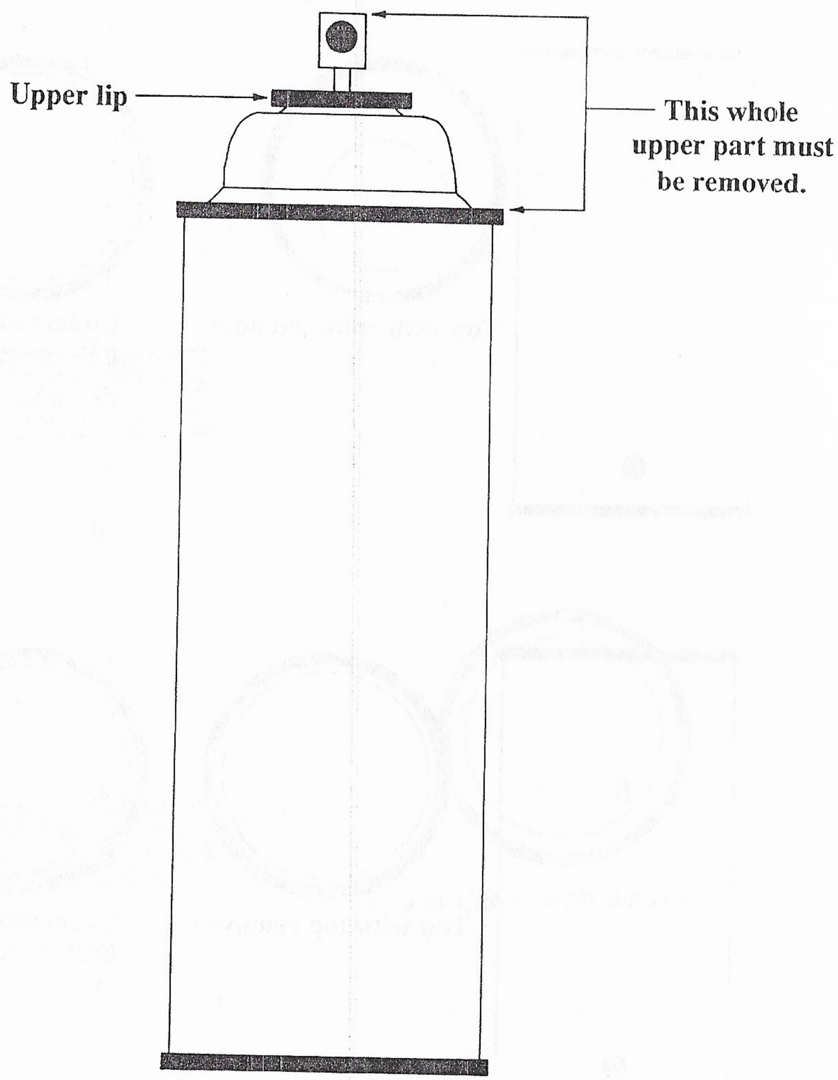

Figure 15

Fueling Procedure

Fueling is the most vital part of operation, because without proper fueling techniques, your homemade mortar will not operate correctly. We have achieved our best results using either lighter fluid or propane as the main fuel.

There are two approaches to using lighter fluid. The first is to put individual drops of lighter fluid directly into each chamber through the fuel/ignition holes. This fluid must be allowed to evaporate in each chamber before ignition. Rolling the can around in your hands for several seconds accomplishes this. The time depends mainly upon air temperature and humidity.

The second method uses a vaporizer, such as a nasal spray container. This breaks down the fluid into a very fine mist which evaporates very quickly and introduces added oxygen into the combustion chamber.

Propane is a very good combustion fuel and can be found at most hardware stores (it is used in brazing and soldering). With propane, a nozzle such as the one used for brazing and soldering will be needed to fill the combustion chamber.

The actual fueling of the mortar is very tricky. Too much fuel and it won't fire or will fire only partially. Too little

and it won't fire at all or will be very weak. A list of appropriate fuel quantities can be found in the Flight Data chapter.

The fueling procedure is as follows:

1. Insert a tennis ball down the launch tube and push it to the bottom with a plunger.
2. Squirt or drop the desired amount of fuel into the combustion chamber or chambers.
3. Roll the mortar around in your hands to let the fuel evaporate in the combustion chamber. It is now ready to be ignited.

Ignition Procedure

Once the mortar has been fueled, it is ready for ignition. Set it on a solid surface that can absorb the recoil, pointed in the desired direction (initial shots should be vertical). Place a lit match or lighter near the bottom ignition/fueling hole; the mortar should ignite with a loud noise. If the mortar does not ignite immediately, try gently squeezing the side of the combustion chamber.

Ignition will be followed by a loud noise and a flame emitting from the launch tube which may or may not be visible. The noise will be a problem with the advanced models. We suggest using hearing protection when firing these models.

There is one irritating problem with ignition. When lighting any of the mortars, hot gases will tend to be expelled from the ignition/fueling hole(s). If your hand is near the hole after lighting it, you could burn your fingers. Try to keep your hand to one side when igniting.

Flight Data

The data compiled below is by no means a complete record of our mortaring experience. It is intended only as an example of some of our tests. The tests were made with the ball traveling straight up. All times are accurate to ±0.2 seconds.

Flight Data for Basic Model

# of squirts (nasal spray)	aeration time (seconds)	shot 1 (seconds in air)	shot 2	shot 3
1	30	5.0	4.2	5.0
2	30	4.5	3.0	3.0
3	30	3.2	2.0	2.2
1	60	4.0	5.2	4.3
2	60	3.8	5.0	4.2
3	60	5.0	3.5	3.5

Flight Data for Intermediate Model

# of squirts (chamber 1/2)	aeration time (seconds)	shot 1 (seconds in air)	shot 2	shot 3
1/1	30	4.8	5.5	5.0
1/2	30	5.0	6.0	6.0

# of squirts (chamber 1/2)	aeration time (seconds)	shot 1	shot 2	shot 3
		(seconds in air)		
1/3	30	5.5	3.5	6.5
2/1	30	7.5	6.5	7.0
3/1	30	6.3	6.0	6.0
2/2	30	6.0	5.8	6.0
2/3	30	6.0	4.5	6.5
3/2	30	5.0	3.2	4.0
3/3	30	6.6	4.2	4.4
1/1	60	3.5	2.0	4.6
1/2	60	2.8	3.8	4.0
1/3	60	4.5	4.0	6.5
2/1	60	4.5	4.5	4.2
3/1	60	6.3	6.5	7.0
2/2	60	6.5	5.0	6.8
2/3	60	6.5	6.2	6.5
3/2	60	6.5	6.5	6.8
3/3	60	6.8	6.9	6.5

Problems

There can be several problems associated with the mortars described in this manual. These include legality, retrieval, damage to property, recoil, lighting and firing, noise, and fueling.

The legal problems are the most important. Before firing, you should check local and state ordinances; operation of this device may be illegal within city limits. The best place to call is either city hall or your local police department.

Care should be taken to keep track of launched balls. We use the yellow variety, but the orange variety would be easier to locate in tall grass.

These balls travel out of the launch tube at a high velocity. Therefore, the mortar should never be pointed at people, buildings, or vehicles, since the ball could cause severe damage to anything it strikes. When launching the ball straight up, make sure the area around the mortar is clear. When the ball comes down, it is traveling rather fast and could cause damage to anything it hits. Just use common sense when launching.

Recoil from all of the designs is potentially fierce. We suggest that, when firing, the mortar be planted firmly on the ground or against some sturdy object. If you are

not careful, the bottom of the mortar can be damaged by recoil.

One persistent problem exists when lighting the mortar — in moderate and even light wind it is sometimes difficult to light, especially with matches. We suggest using a lighter, preferably a piezoelectric model. A wind brace greatly facilitates ignition as well. Overfueling the mortar will often prevent it from lighting, so make sure you have the correct amount of fuel in the chamber.

Noise is not too much of a problem with the basic model, but with the intermediate and advanced models, the noise can be rather loud. We suggest wearing some type of ear protection.

Proper fueling is probably the most important step, since it is crucial for high, long flights. Fueling, however, can sometimes be tricky. Individual drops of fuel can be dripped into the combustion chamber, but we suggest using a vaporizer such as an empty nasal spray container to get a better fuel/oxygen ratio.

A few other minor problems have arisen. The most persistent occurs during ignition. As mentioned earlier, if your hand is in front of the ignition/fueling hole, you could get burned during ignition. To prevent this, hold your hand off to the side.

Another problem is that the duct tape around the ignition/fueling hole tends to melt somewhat after repeated shots. After several weeks of use, the tape tends to lose its adhesive qualities and will need to be replaced periodically.

Troubleshooting

For various reasons, you will encounter some difficulties when operating your mortar. We will try to address some of these below.

If the mortar doesn't ignite after fueling, try squeezing the bottom combustion chamber slightly. When you let go, the flame will be sucked into the chamber and ignition should occur. If it still does not ignite or only a slight flame is seen, it could be a sign of overfueling or insufficient aeration time. After each launch, it is a good idea to air out the mortar by swinging it around several times. Apply a flame to the ignition hole and "flame it out." When flame-out does not occur, it is ready for use.

The heat and high pressures produced will cause wear on the mortar. Specifically, the duct tape has a tendency to melt or tear after prolonged use. Either retape or just tape over the old tape. Aluminum tape may also be used.

A good way to prevent damage is to wrap the whole mortar in tape. This strengthens it considerably and provides some heat insulation.

Afterword

We've discovered several helpful tips after constructing all of these mortar designs. First, aluminum is an easy metal to work with. It gives well and absorbs shock well. Aluminum cans also create a good seal for the ball.

Second, the nap (fur) on the tennis ball helps create a good seal. After a couple of shots, however, most of the nap will have burned off. Different brands of tennis balls seem to fit differently.

Air temperature seems to have a direct effect on the performance of the mortar. The cooler the air, the worse the performance. This is also true of humidity, since in both cases the fuel evaporates slowly. Generally, the warmer and dryer the air, the better the performance.

One of the biggest problems you will encounter is fuel residue. After launching, some fuel residue will be left in the combustion chamber, consisting of naphtha and other oils from the ignited lighter fluid. After several launches the mortar will not perform at capacity and a flame-out will be needed. You may need to flame out the mortar several times before it is ready for another launch.

Some brands of soft drink cans fit more tightly than others. Experimenting will help you find the best fit.

We continue to build and test other mortar designs.

Currently in the design phase are mortars using coffee cans and large gallon paint cans, multiple launch tube mortars, versions that shoot other ammunition (such as golf balls), and others.

We hope you have enjoyed this manual and enjoy mortaring! Questions and suggestions should be sent to the address on the warning page.

Terms

Aeration time — The amount of time between the fueling and ignition of the mortar, usually between 15 and 60 seconds.

Combustion chamber — The section of cans in which the air/fuel mixture ignites and expands rapidly.

Flame-out, clean out — The post-launching process in which the residual fuel left in the combustion chamber is re-aerated and reignited in order to clean out the mortar for another launch.

Ignition/fueling hole — The hole drilled in the bottom of the combustion chamber that allows fuel to be loaded and ignited. Optimum size is 1/8″ in diameter.

Launch tube — The connecting cans that make up the acceleration tube or barrel.

Trajectory — The flight path taken by the ball in the air after launch. This is determined by the initial muzzle velocity and angle at which the ball is launched.